2.3.3. Elevation Angle Limits

2.3.3.1. Purpose

The purpose of this test is to determine the elevation angle limits of the radar and their effects upon the utility of the radar search volume.

2.3.3.2. General

As with the scan angle limits, the elevation angle limits of the radar are often established by the limits that the antenna can be slewed up or down. These limits can be physical, caused by space or gimbal constraints within the nose cone or by interference between the radar beam and the airplane structure. The latter is less likely for the elevation limits than for the azimuth limits.

Elevation limits are important to radar performance because they are another constraint upon the minimum detection and tracking range. Under most search situations, the elevation limits do not come into play since at medium and long range the angle to the target from horizontal will be small; however, for close targets, above or below the airplane, the maximum angle can significantly effect both detection and tracking. Two examples of situations when elevation angle limits are at issue are during ACM and airborne tanking. While maneuvering behind the target, the target must be kept within the upper and lower gimbal limits to prevent the radar from losing contact and when tracking, from breaking lock.

Generally, most modern radars will maintain detection and tracking on targets to 60° above and below the centerline. The definition of the centerline varies from airplane to airplane (airplane waterline, weapons line etc.); however, they are typically all within a few degrees. Since the upper and lower limits are critical during ACM and air-to-air refueling, the limits should be quantitatively measured to establish the numerical angular limits and then qualitatively evaluated during ACM maneuvers against a mission relatable target and during actual or simulated approaches to the tanker.

One anomaly of the radar elevation limits is noteworthy. Often the radar will track a target beyond the physical antenna limits by locking onto the target while it is in the radar antenna sidelobes. This is particularly prevalent when the target is close and the sidelobe returns are strong. A visual estimate of the angle to the target compared to the elevation angle of the antenna indicated by the radar display will quickly indicate this problem since the first strong sidelobe is often 30° to 40° off of the radar mainlobe.

2.3.3.3. Instrumentation

Data cards are required for the test with an optional voice recorder.

2.3.3.4. Data Required

Record the antenna elevation indicated by the radar display as tracking is lost for both the upper and lower limit. Note any times the angle to the target obviously exceeds the displayed angle with detection or tracking still present. Record qualitative comments concerning the maximum antenna elevation limits during ACM maneuvers and simulated or actual tanking.

2.3.3.5. Procedure

Place the target on the test airplane nose at 1/2 nm with the target at the same heading and speed as the test airplane and 1,000 feet above the test airplane. Establish STT. The test airplane should then increase speed and slowly close on the target, maintaining a constant altitude until tracking and detection is lost. Visually estimate the angle up to the target. Re-establish a 1/2 nm trail and climb the test airplane to 1,000 feet above the target, repeating the procedure for the lower gimbal limit. The test airplane will have to roll to either side to visually check the angle to the target. During ACM tests, qualitatively evaluate the utility of the gimbal limits as the target pulls inside of the test airplane (upper limit) and as the test airplane leads the target (lower limit). As time allows, attempt a simulated approach to the target as the target flies straight and level, simulating a tanker airplane. Use the recommended tanking procedures for the test airplane.

2.3.3.6. Data Analysis and Presentation

Use the radar display antenna angle at broken lock as a measure of the antenna elevation limits. Compare the measured antenna angle to the visual estimate to check for sidelobe detection or tracking. Relate the presence of

sidelobe tracking to the false antenna pointing angle during ACM and tanking, and the reduced likelihood of visual detection (the operators will be led to look in the wrong direction for the target). Relate any anomalies noted during ACM or simulated or actual tanking to the possibility of broken lock or lost detection during these scenarios. Use the measured limits to back up the qualitative comments.

2.3.3.7. Data Cards

A sample data card is provided as card 7.

CARD NUMBER ___ TIME PRIORITY L/M/H

AIR-TO-AIR ELEVATION ANGLE LIMITS

[JOIN ON TARGET 1/2 NM IN TRAIL. PLACE THE TARGET AT THE SAME HEADING AND 1,000 FEET ABOVE THE TEST AIRPLANE. ESTABLISH STT. CLOSE ON THE TARGET UNTIL TRACKING AND DETECTION IS LOST. NOTE THE ANTENNA ELEVATION ANGLE UPON THE RADAR DISPLAY AND VISUALLY ESTIMATE ANGLE. REPEAT WITH THE TARGET 1,000 FEET BELOW.]

UPPER/LOWER	ANTENNA ANGLE	VISUAL ESTIMATE

[ELEVATION LIMITS QUALITATIVE COMMENTS DURING ACM AND TANKING.]

TYPE OF MANEUVER_____

EFFECTS:

Card 7: Air-to-Air Elevation Angle Limits Data Card